Study of bunch length limits

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Goals:

- To identify and observe effects which put limits on the minimum bunch length in RHIC.
- To distinguish the limitation coming from resistive wall heating and electron cloud (vacuum, pipe heating) and identify the heat load on the beam pipe from both effects.

Motivations and benefits

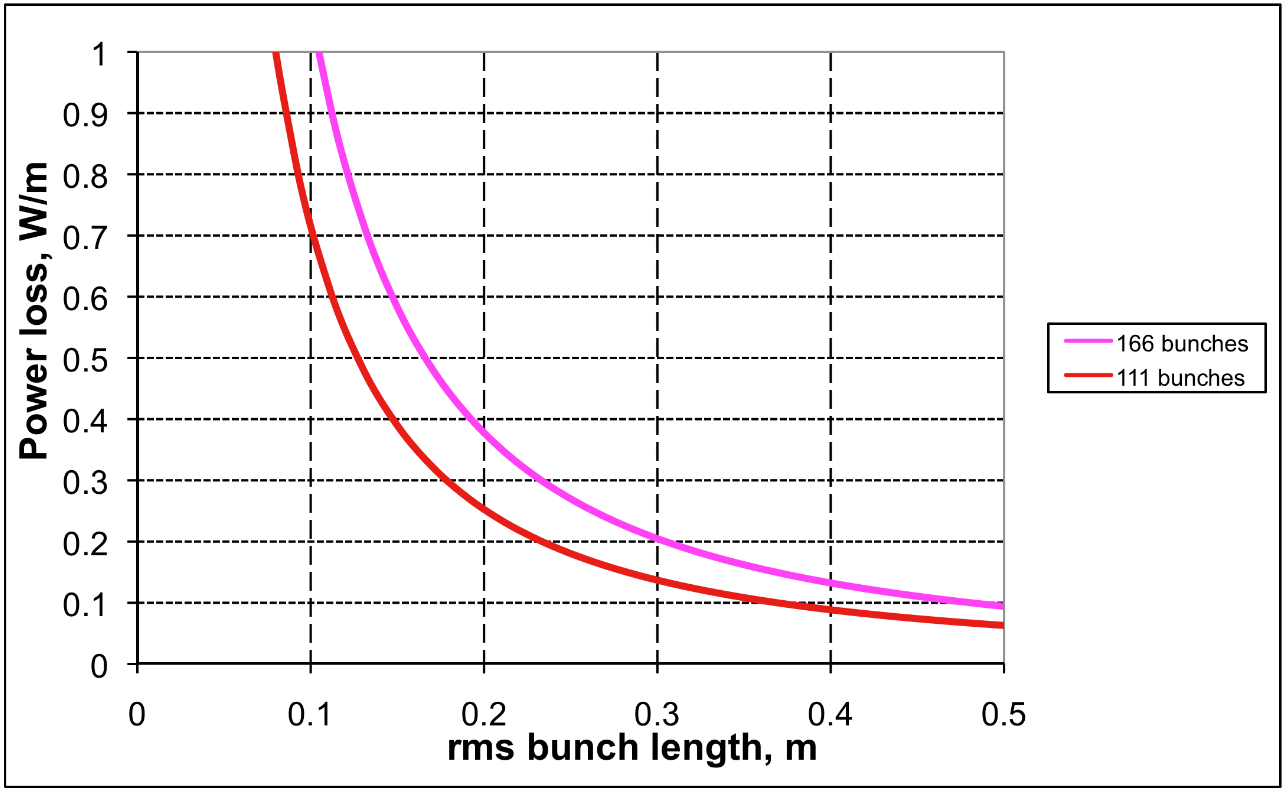
- The bunch length of less than 1ns rms value is expected with 56 MHz RF system and in the eRHIC design.

- In eRHIC smaller bunch length would allow:
  - to reach smaller beta* and higher luminosity. Present IR design can provide beta* as low as 5cm.
  - to use crab-crossing collision geometry. It simplifies tremendously handling synchrotron radiation issues in the IR.

  Bunch length < 10cm needed.

- The quantitative knowledge of the limiting factors will help to better specify the achievable luminosity of eRHIC and to clarify expectations for 56 MHz RF operation at RHIC.

Resistive wall power load



$N_b = 2*10^{11}$

Experiment description

- Inject the proton bunches with intensities about 2-2.5e11.
- Use 28 MHz RF system with highest possible voltage and, possibly, quad pumping technique in AGS.

- Slowly approach the RHIC transition to achieve shorter and shorter bunch length and record data on cryo-temperatures, vacuum condition, transverse and longitudinal beam sizes (emittances).

- To approach the transition two ways will be used (probably, combined): ramping gammaT quads (to oppposite strength than they are used now, and even further, if possible) and slow energy ramp down (so, individual ramp should be created).

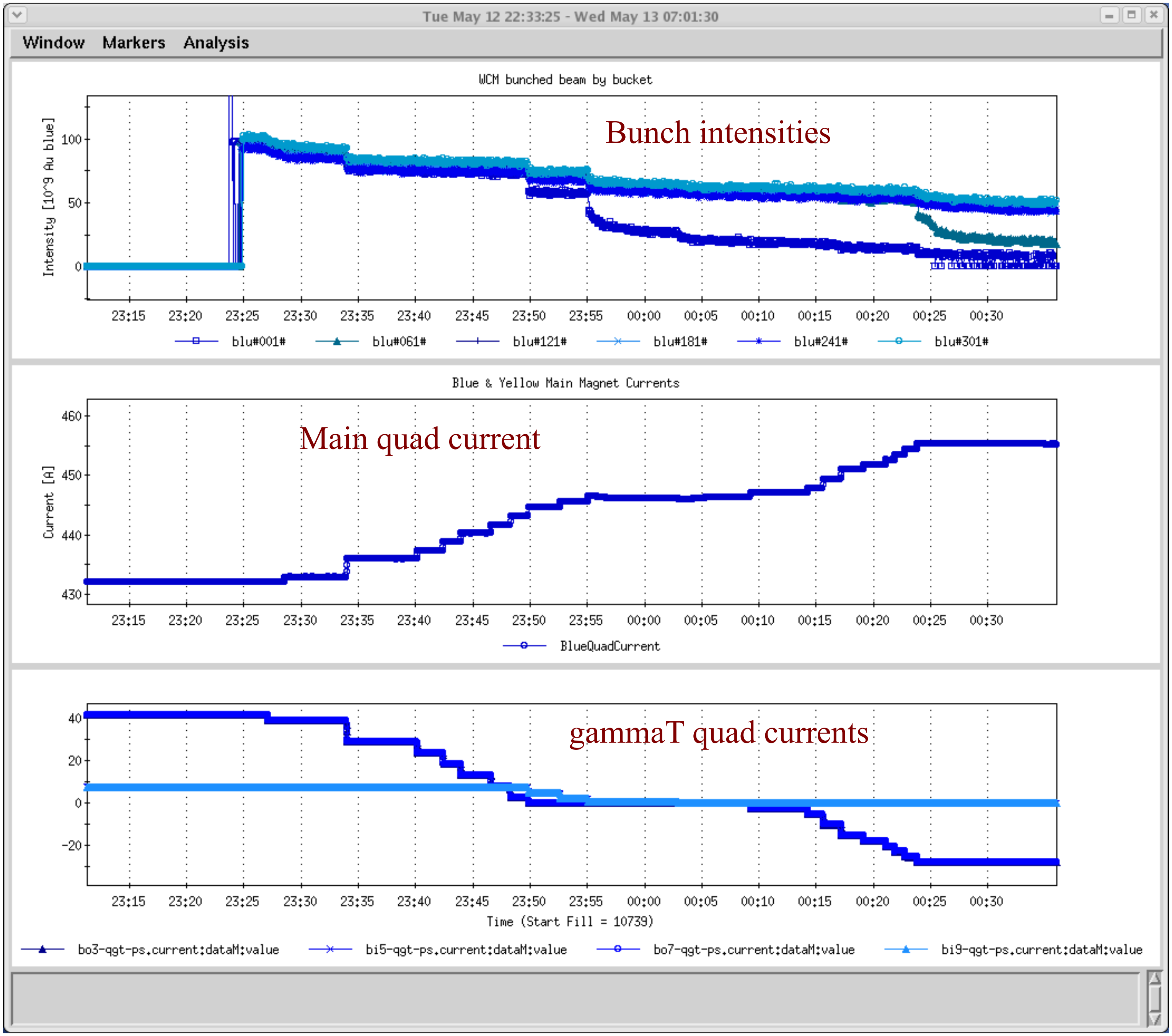
- These measurements have to be done 2 or 3 times with different bunch patterns (to vary the electron cloud production) but maintaining the same n_b*N^2 value (to have the same resistive wall contribution).

Bunch length studies at the injection energy

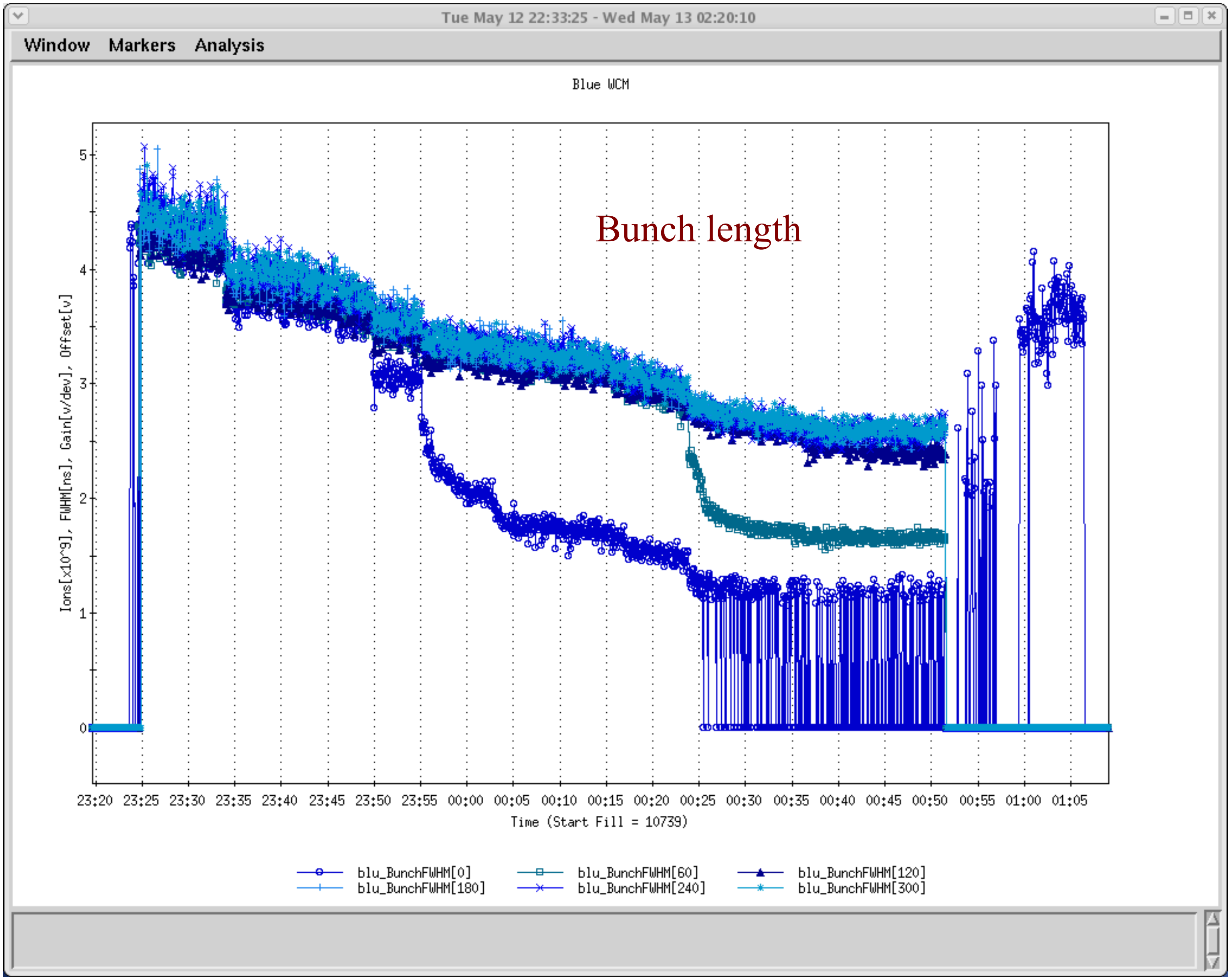
- Main goal: to observe increase in cryoload due to resistive wall and electron cloud.

- However the measurements at the injection energy are complicated by the space charge effect and possible instabilities when shortening bunch.

Approaching transition using gammaT quads in Run-9



Approaching transition using gammaT quads



Approaching transition study in Run-9

- Difficulties identified during the use of gammaT to approach the transition:
  - Beam losses when large step of gammaT quad change was used
  - Some model problems when trying to calculate the required tune correction.
  - Considerable closed orbit change.

Plans for 2011

Three options for carrying on the experiment are under consideration:

- Do the same way as in 2009, but use the tune and orbit feedbacks in order to prevent the tune excursions and the orbit deterioration.
- Use a dedicated ramp which will contain gammaT quad variations and corresponding tunes and orbit corrections.
- Use a dedicated ramp which will approach the transition by (small) deceleration.

Experiment Proposal:
Dependence of the quench limit on the mass of lost ions

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Heavy ions deposit energy with very high local density. This leads to strong dependence of the radiation damage on the mass (or charge) of the projectile ion.
So far, there is no data available in literature for the dependence of the quench limit of the superconducting material on the energy (or heat) deposited by different heavy ions.
We suggest measurement of the quench limit triggered in RHIC superconducting magnets by different heavy ions.

Description of the experiment

- The irradiation should consist in two runs at least: A superconducting magnet of RHIC should be irradiated with at least two types of beam projectiles. In one run it should be a proton beam. In the other one a beam of ions with the highest possible mass number (Au, for example) is desirable.

- The beam should be directed to one of the superconducting magnets and with a gradual increase of the beam intensity the quench limit for the magnet should be determined. Ideally, it is desirable to check also the reproducibility of the quench limit. But if the magnet recovery time is too long, even one observation of the quench event might be helpful.

- The expectation is that the quench limit for the heavy ion beam is lower compared to the quench limit determined for the proton beam.